M56

MEDIUM GAIN
D.C. PREAMPLIFIER
MODEL 13-4615-10
S/N 17000 AND ABOVE

GOULD
Electronics

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Electronics

MANUAL PART NO.
13-804615-10

MEDIUM GAIN
D.C. PREAMPLIFIER
MODEL 13-4615-10
S/N 17000 AND ABOVE

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PRINTED 3-85
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Gould Inc., Recording Systems Division
3631 Perkins Avenue, Cleveland, Ohio 44114

21ST PRINTING
PRINTED IN U.S.A.

CAUTION

THIS UNIT HAS D.C. VOLTAGE POTENTIAL AVAILABLE AT THE INPUT CONNECTOR ON PINS 6& 7.

(See Section 2.4 in this manual) .

OBSERVE PROPER POLARITY WHEN CONNECTING TO THOSE PINS OR DAMAGE MAY RESULT TO THE RECORDER AS WELL AS YOUR SIGNAL SOURCE .

The following information is intended to alert the user to possible dangers and important information contained in this manual. The "WARNINGS" and "CAUTIONS" do not eliminate the dangers that they signal. Close attention to the information supplied plus "common sense" operation are the major accident prevention measures.

WARNING:	Failure to follow this warning may result in bodily injury.

CAUTION:	Failure to follow this caution may result in possible damage to the product or equipment.

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WARRANTY

CURRENT EQUIPMENT:

Gould Inc.'s Recording Systems Division's products as shown in the Current Equipment Catalog are warranted for a period of one year from date of shipment to original purchaser. Exceptions: the thermal pen in the 110 Strip Chart Recorder is guaranteed for life; the magnetic head assemblies in the Tape Recorder are warranted for 1000 hours of use or one (1) year from date of first shipment whichever occurs first; and the mainframe computer for Data Acquisition Systems and their associated software programs are warranted for 90 days. The IBM PC-AT computer is warranted for one (1) year.

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Gould offers an Extended Warranty Agreement for all its products, along with calibration traceable to NBS. Please contact the Service Center listed on the following pages for details before your warranty expires.

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Compliance with the above procedure will assure the earliest repair and return of your equipment.

10-1-85

Gould instruments are individually tested and calibrated before shipment to assure dependability and verify their accuracy. To this procedure must be added an unseen ingredient of prime importance to you: The Gould concept of continuing service. Gould responsibility for each instrument sold covers far more than its delivery. Of equal concern is the equipment's suitability for its intended purpose, its correct installation, instruction of operating personnel -- plus future servicing and maintenance. The Gould Field Service Department offers customers any or all of these services:

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- o Installation
- o Field maintenance
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Training

- o Instruction of operators
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Service Contracts

- o Fixed Fee
- o Time and Material
- o Extended Warranty

Our Seal of Pride Gould Inc., Recording Systems Division, and its predecessor organizations tracing back to Charles F. Brush, have been preeminent in instrumentation development since the 1920's. Among Gould's many achievements is a series of the world's best performing, most versatile, and reliable direct writing recording systems.

Today, Gould recorders and signal conditioners are the overwhelming choice for recording analog signals in the most critical industrial, scientific, and biophysical measurement applications. Whether recording the faintest life signals of a patient in a hospital operating room or the most critical variables in the lab or on the production line, you can depend on the accuracy, faithfulness, clarity, and permanence of the traces made by a Gould recorder.

Innovative design, coupled with highest quality, are hallmarks of all Gould products.

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Our field service engineers and technicians are daily engaged in the installation, testing, maintenance, repair and inspection of Gould recording systems all over the country. They can provide you with any information about our instruments you may require; if not, they will find the answer to your problem.

Overhaul and Repair Because we service only our own products, our customers can feel confident of prompt, effective results when they turn to Gould Factory Service Centers.

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An extended warranty is available at the point of sale allowing a regulated budget for the first two years of ownership. You may take advantage of this warranty within the first year of ownership at a percentage of the current listed price.

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January 1987

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Gould Model 13-4615-10 D.C. Preamplifier (Figure 1-1) is a balanced to common medium gain signal conditioner designed for use with Gould 2000 series recorders. It receives its operating power from a companion pendrive amplifier located in the recorder.

This single channel preamplifier module provides a maximum sensitivity of 25mv F.S. on Gould 2000 series recorders. It has been specifically matched both electrically and mechanically for use with any Gould 2000 recorder.

The amplifier response is less than 3db down at 2KHz with filter off; flat to ±.5% from dc to 100Hz with filter off.

This preamplifier is a fully enclosed solid state unit of sturdy construction incorporating the latest components and assembly practices.

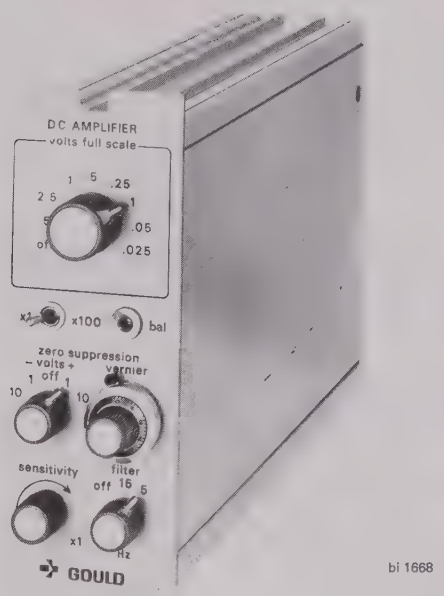


FIGURE 1-1 GOULD MODEL 13-4615-10 MEDIUM GAIN D.C. PREAMPLIFIER

1.2 SPECIFICATIONS

Signal Input

Circuit . . . . . Balanced to Common

Impedance . . . . . 2 megohms differential; 1 megohm each terminal to common.

Measurement Range . . . . . 25 millivolts full scale to 500 volts full scale.

Sensitivity Steps . . . . . .025, .05, .1, .25, .5, 1, 2.5 and 5 volts full scale, and "off"; plus x1 and x100 multiplier.

Variable Sensitivity . . . . . Minimum of 2.5X multiplication of calibrated steps.

Maximum Safe Voltage . . . . . 500 Volts peak-either input terminal to common or chassis. 500 Volts peak-common to chassis.

Signal Output

Circuit . . . . . Single ended to common.

Voltage:

Linear Range . . . . . ±5.0 volts into 5Kohms or greater.

Minimum Load Resistance . . . . . Zero ohms (Short Circuit proof).

Calibration Inaccuracy . . . . . ±0.1% of full range in the least sensitive position at 25° C and nominal line voltage.

Signal Output (continued)

Attenuator Inaccuracy . . . . . ±0.5% of calibrated step.

Non-Linearity . . . . . ±0.1% of full scale.

Impedance . . . . . Less than 5 ohms.

Instability:

Zero with Time . . . . . ±3 millivolts/24 hours on the most sensitive range after 15 minutes warmup; decreasing on less sensitive ranges.

Zero with Temp . . . . . ±3 millivolts/° C on the most sensitive range after 15 minutes warmup; decreasing on less sensitive ranges.

Zero with Line . . . . . ±1 millivolt for 10% line change.

Gain with Time . . . . . ±0.01%/24 hours after 15 minutes warmup.

Gain with Temp . . . . . ±0.03%/° C.

Gain with Line . . . . . ±0.01% for a 10% line change.

Frequency Response . . . . . Less than 3db down at 2KHz with filter off; flat to ±.5% from dc to 100Hz with filter off.

Noise . . . . . Less than 10mv peak-to-peak from dc to 100Hz on the most sensitive range.

Common Mode Rejection:

Inputs 1 and 2 to Common . . . . . DC to 60Hz: Greater than 55dB@ 1 Kohm unbalance on the x1 ranges, decreasing on the x100 ranges.

Common to Chassis . . . . . 60Hz: Greater than 100db @ 1Kohm unbalance on the most sensitive range decreasing on higher ranges. D.C. greater than 120db @ 1 Kohm unbalance on the most sensitive range decreasing on higher ranges.

Linear Common Mode Voltage:

Inputs 1 and 2 to Common . . . . . 10 volts maximum in x1 position. 500 volts maximum in x100 position.

Common to Chassis . . . . . 500 volts maximum, all ranges.

Zero Suppression

Range . . . . . -10, -1, "off" +1, +10 volts. Range is multiplied x100 by multiplier switch (maximum ±500 volt).

Inaccuracy . . . . . ±.5% of suppression range at nominal line and 25° C.

Zero Suppression (continued)

Non-Linearity	±.25% of full suppression range.
Resolution	±.1% of full suppression range.
Stability:	
With Time	±0.02%/week
With Temp	±0.02%/° C
With Line	±0.02% for ±10% line change.
Noise	.05% of full range

Filter

Range	"Off", 15Hz, 5Hz.
Cutoff Frequency	-3db @ 5Hz (±20%) -3db @ 15Hz (±20%)
Attenuation	-12db/Octave

Environment

Temperature:	
Storage	-40° C to +70° C.
Operating	0° C to +50° C.
Humidity, Non-Condensing:	
Operating	95% relative humidity; 0° C to 30° C. Less than 95% relative humidity; 30° C to 50° C.

Physical Characteristics

Dimensions	Refer to Figure 2-3 Outline Dimensions.
Weight	3.6lbs (1.5kg)
Mounting	Retained from Rear
Finish	Molded Front Panel, Color: Light Parchment.

Controls

Front Panel:	
Volts Full Scale	Sets full scale sensitivity of preamplifier.
x1 — x100 Toggle Switch	Multiplies setting of volts full scale switch.
Bal	Sets zero of preamplifier in the most sensitive position, and off position.

Controls (continued)

Zero Suppression (-volts +) . . . . . Selects full scale suppression voltage and polarity.

Zero Suppression (vernier) . . . . . 10 turn potentiometer allows calibrated setting of suppression from 0% to 100% of range.

Filter . . . . . Selects either 5Hz or 15Hz -12db/octave filter.

NOTE: No Pen Position Control.

Internal:

Zero . . . . . Single turn potentiometer. Sets zero of output stage.

Cal. 1 . . . . . Single turn potentiometer. Sets basic accuracy of preamp.

Cal. 2 . . . . . Single turn potentiometer. Sets common mode rejection in the x1 position.

Input Bal . . . . . Single turn potentiometer. Sets common mode rejection in the x100 position.

10V ADJ . . . . . 10 turn potentiometer. Sets accuracy of 10 volt suppression range.

1V ADJ . . . . . Single turn potentiometer. Sets accuracy of 1 volt suppression range.

Rear Panel:

Input . . . . . Guarded 2 pin connector (Proprietary). Mating connector 11-5407-02 supplied.

Output . . . . . Card edge mates with AMP 582140-5 or equivalent.

Power Input From Recorder

Voltage DC . . . . . ±15 volts, ±0.6 volts @/5 ma.
Voltage AC . . . . . 13vrms @ 200 ma.

Line and Load Regulation . . . . . ±0.5%.

Ripple . . . . . 5mv rms max.

System Specifications When used with Series 2000 Recorder

Gain Accuracy . . . . . 0.7% of full scale.

Non-Linearity . . . . . 0.45% of full scale.

Instability:
Zero with Time . . . . . ±0.15% of full scale/24 hours in the most sensitive position.

System Specifications When used with Series 2000 Recorder (continued)

Zero with Temp	±0.085% of full scale/°C.
Zero with Line	±0.15% of full scale for ±10% line change.
Gain with Time	±0.11%/24 hours.
Gain with Temp	±0.08%/°C.
Gain with Line	±0.5% for a ±10% line change.
Frequency Response	Refer to Specifications, 2000 Series Recorder Manual.
Noise	±0.25% of full scale.
Maximum Safe Input	±500 volts peak voltage
Common Mode Rejection	Refer to Specifications, page 1.2 of this manual

Accessories

Supplied with preamplifier

- Input Connector (Male) 11-5407-02

Optional - May be ordered separately

- Extender Card and Cable Assembly 887291
- Input Connector Adapter. Converts input connector to 3 "binding post" terminals 11-5407-09
- Input Connector Adapter. Converts input connector to 6-pin Cannon connector receptical 11-5407-06

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the checks and inspections that should be made upon receiving the Gould D.C. Preamplifier Model 13-4615-10 with a 2000 series unit. It covers; installation procedures, signal input connections, and outline dimensions.

2.2 INITIAL INSPECTION

Prior to attempting any electrical connections or operation visually examine the unit for; broken or loose knobs, dented or nicked panels and broken or chipped rear connectors.

2.3 INSTALLATION

Preamplifier Model 13-4615-10 may be mounted in Gould 2000 Recorder frames, or rack mounted separately in a Gould rack adapter kit.

a. Insertion

To install the preamplifier into its appropriate slot:

1. Slide the preamplifier into the enclosure until the rear output card edge connector is engaged.

2. Tighten the rear retaining screw. This locks the preamplifier into the enclosure.

3. Connect the 2-pin plastic input signal connector and secure it by turning the threaded plastic locking ring clockwise.

b. Removal

1. Disconnect the input connections with a counterclockwise turn and pull.

2. Loosen the rear retaining screw. The preamplifier will move forward about 1/8 of an inch.

3. Carefully slide the entire preamplifier out of the Gould 2000 enclosure.

2.4 SIGNAL CONNECTIONS

a. General

Gould preamplifier Model 13-4615-10 is a direct coupled, balanced to common dc preamplifier. Input and output are isolated from chassis, but there is no isolation between input and output. See Figure 2-1, Amplifier Diagram.

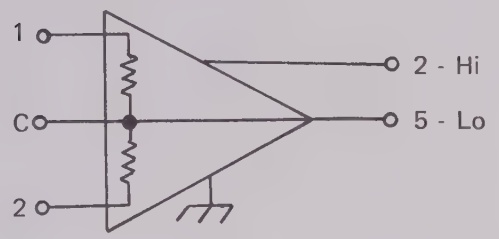


FIGURE 2-1 AMPLIFIER DIAGRAM

The preamplifier can be used with any signal input up to 500 volts peak. The source may be floating, balanced to ground or single ended-grounded.

If either the common input lead or the low side output lead is grounded, the amplifier becomes a balanced to ground amplifier. For details on signal input connections and sources refer to Section VI.

b. Input Connection Hardware

NOTE: For signal input connections, use the special connector provided with the preamp (Gould Model Number 11-5407-02).

Connections to the preamplifier are made at the rear (Figure 2-2). A good two wire shielded cable (Gould P/N 232434) should be used.

NOTE: Pin 6 (-15V) and Pin 7 (+15V) output available (see Schematic 286367).

c. Output and Power

The amplifier is designed to operate on + and -15 volt, 100 ma regulated supplies, and 13 vrms, 200 ma AC. Output and power connections are provided through an 8 pin card edge on the rear of the preamplifier (Figure 2-2). The mating connector is located in the recorder chassis.

The preamplifier provides a 5 volt full scale signal to the recorder. If the user desires, this output is accessible on the rear of the recorder by means of a phone jack.

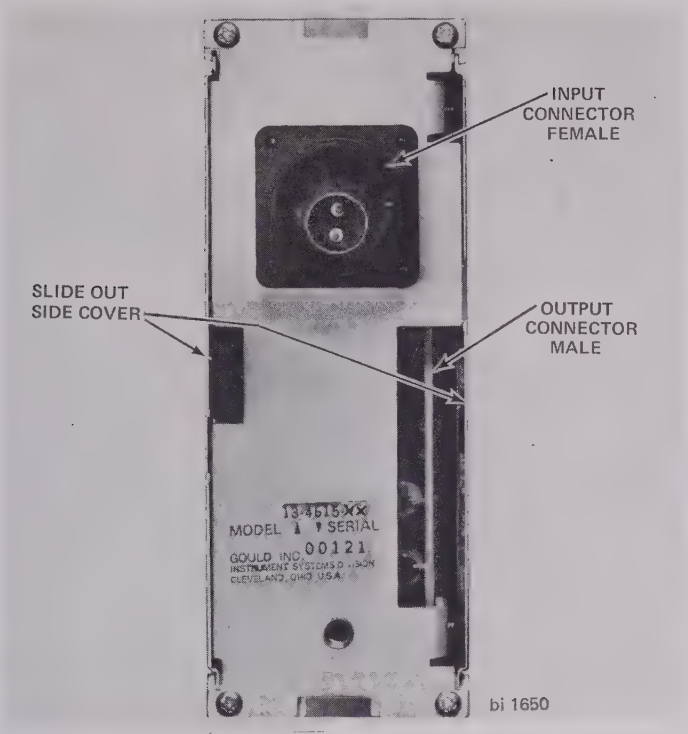


FIGURE 2-2 REAR VIEW

2.5 OUTLINE DIMENSIONS

Refer to Figure 2-3 for outline dimensions.

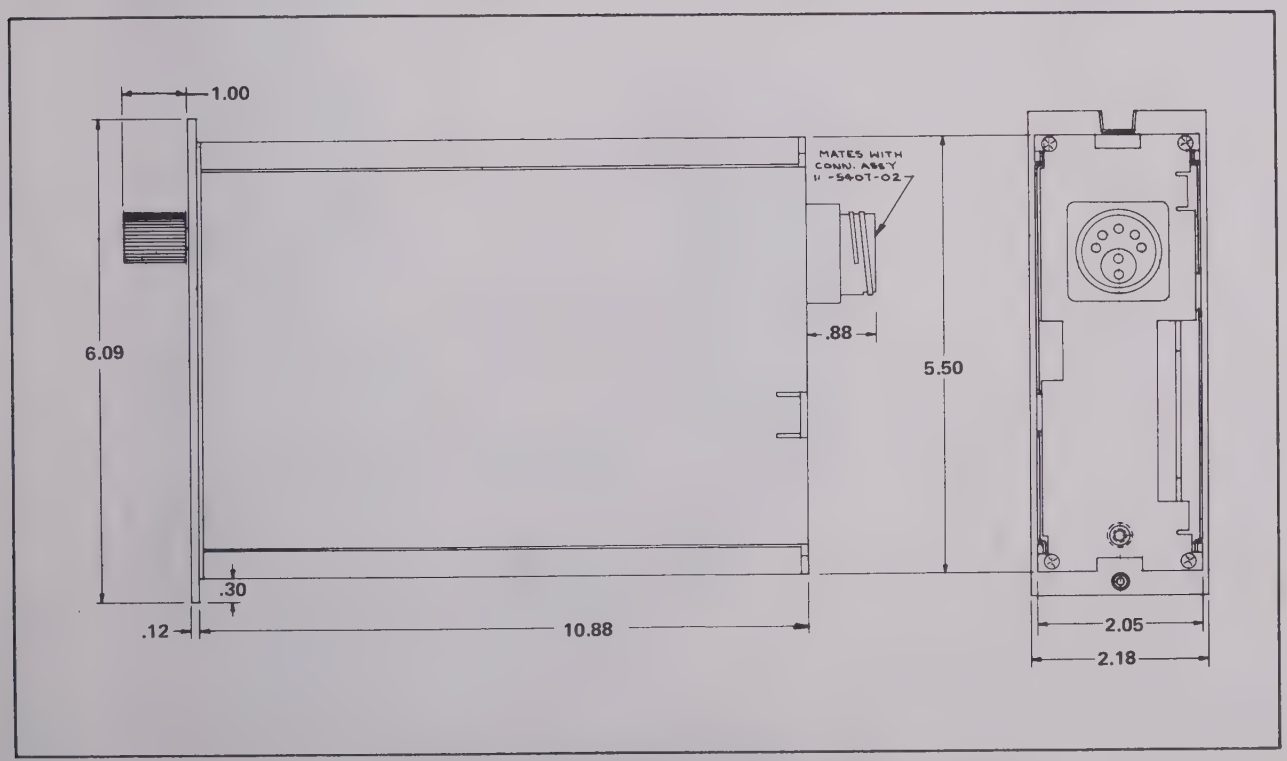


FIGURE 2-3 OUTLINE DIMENSIONS

SECTION III

OPERATION

3.1 GENERAL

This section describes and illustrates the controls of the medium gain preamplifier, Model 13-4615-10 and provides operating instructions.

3.2 CONTROL DESCRIPTION

Item numbers listed below correspond to circled numbers in Figure 3-1.

ITEM	CONTROL	DESCRIPTION
1	Volts Full Scale	A nine position rotary switch allows selection of .025, .05, .1, .25, .5, 1.0, 2.5, 5.0 volts full scale for overall system sensitivity, and an OFF position.
2	x1, x100 (multiplier) switch	Permits selecting sensitivities of 100 times indicated control markings; sensitivities become 2.5, 5, 10, 25, 50, 100, 250, 500 volts full scale.
3	Bal (adjustment)	Sets the zero of the amplifier in the most sensitive position.
4	Zero Suppression (Range) . . . . . - Volts +	Selects full scale suppression voltage and polarity.
5	Zero Suppression . . . . . Vernier	10 turn potentiometer allows calibrated setting of suppression from 0% to 100% of range.
6	Sensitivity	Minimum of 2.5X multiplication of calibrated steps.
7	Filter	Selects either 5Hz or 15Hz -12db/octave filter.

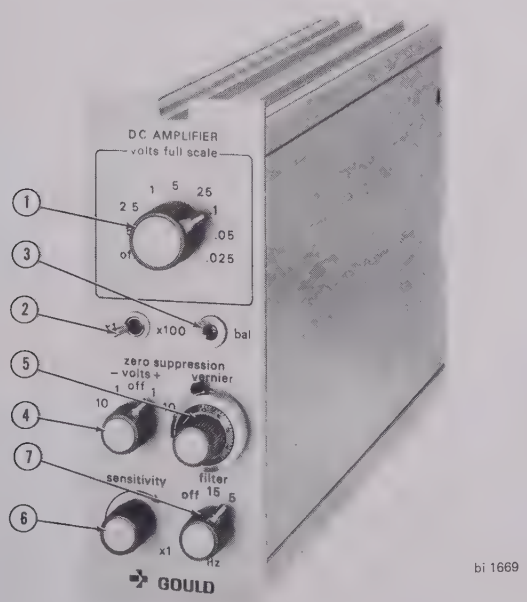


FIGURE 3-1 FRONT PANEL CONTROLS

3.3 PRELIMINARY OPERATION

CAUTION: ALL PROCEDURES OUTLINED IN SECTION II, INSTALLATION SHOULD BE COMPLETE BEFORE ATTEMPTING PRELIMINARY OPERATION.

1. Set VOLTS FULL SCALE to OFF position.
2. PLACE X1/X100 switch in X1 position.
3. Turn SENSITIVITY X1 to FULL clockwise detent position.
4. Connect input cable and short both inputs to common.
5. Apply System power. Allow unit to warm up for 15 minutes.
6. Operate oscillograph at moderate chart speed.
7. Adjust pen POSITION control on oscillograph for approximate chart center.
8. Turn to the most sensitive position and use the BAL control to set zero if necessary.
9. Stop recorder and connect input signal to preamplifier.
10. Preamplifier is now ready for normal operation.

3.4 UNCALIBRATED OPERATION

To obtain more useful records, it may be desirable to operate the amplifier with the sensitivity X1 vernier control in other than the detent position.

3.5 CALIBRATED ZERO SUPPRESSION

a. General

Zero suppression permits the dc component of a complex wave form to be suppressed, thus allowing a small dynamic portion to be further amplified. Calibrated zero suppression indicates the magnitude of the dc voltage which has been suppressed. The zero suppression is independent of attenuator setting and amplifier sensitivity. This feature permits the attenuator settings to be changed without resetting the zero suppression.

b. Application of Zero Suppression (Signal less than 10V)

To examine the dynamic component (or components) or signal with a static (dc) level below 10 volts, proceed as follows:

1. Turn the VOLTS FULL SCALE control to the OFF position.
2. Place the X1/X100 switch in the X1 position.
3. Turn ZERO SUPPRESSION RANGE control (-volts+) to the OFF position and the VERNIER control fully counterclockwise.
4. Turn X1 SENSITIVITY control fully clockwise to the detent position.
5. Operate the recorder at a nominal speed and set the pen to chart center.
6. Advance the VOLTS FULL SCALE control clockwise until the pen approaches the edge of the chart.
7. Note whether the signal is greater or less than 1 volt and note the polarity also.
8. Set the ZERO SUPPRESSION RANGE control (-volts+) to the appropriate range and use the VERNIER dial to bring the pen to the center of the chart.
9. Advance the VOLTS FULL SCALE Control clockwise until the desired sensitivity of the dynamic signal is obtained. Bring the signal to chart center with the ZERO SUPPRESSION VERNIER.
10. Read the peak-to-peak value of the dynamic signal from the recorder chart.

    NOTE: On high sensitivity settings, and the RANGE control set to + or -10V, the resolution fo the VERNIER control may limit the ability to set the pen trace to center zero.

11. The average value of the static portion of the signal is read from the VERNIER dial.

    A signal greater than 10 volts may be examined in a like manner by placing the X1/X100 switch in the X100 position. (The zero suppression range is increased by a factor

of 100).

NOTE: The maximum allowable signal is + or -500 volts.

3.6 FILTER OPERATION

To eliminate 60 Hz or other unwanted frequencies a two position filter is provided. The user has the option of either 15Hz or 5Hz band width (-3dB). The filter is a two pole -12dB/Octave type.

3.7 ZERO ADJUSTMENT

During extended operation of the amplifier or under extreme temperature variation, it is advisable to check the amplifier zero. The following is recommended:

1. Remove the input signal and short the amplifier inputs to common (pins 1, 2 and shield of J101).
2. Set VOLTS FULL SCALE control to OFF.
3. Run recorder at moderate speed and use pen position pot to set pen to center zero.
4. Set VOLTS FULL SCALE control to most sensitive position.
5. Adjust front panel BAL pot to rezero output if necessary.
6. Return VOLTS FULL SCALE control to the OFF position. Amplifier is now ready to use.

NOTE: If the amplifier does not return to zero in the OFF position, an internal potentiometer will have to be adjusted. See the Calibration Section.

3.8 FUNCTIONAL TEST PROCEDURE

This procedure should be performed to verify operation and calibration of the unit. If the output is within the tolerance given, no calibration is required. If not, refer to Section V of this manual.

1. With the Volts Full Scale to .025V position, Filter OFF, Sensitivity fully clockwise to X1 and Zero Suppression OFF, short together J101 pins 1 and 2 and connect to common. Output should be 0V $\pm$5mv.
2. Remove jumpers shor ting inputs together and to common. Set Volts Full Scale to 5 position and apply +5vdc to input. Output should be +5vdc $\pm$5mv.
3. Change input to +10vdc. Set Zero Suppression switch to +10 and vernier dial to 10.00. Output should be 0V $\pm$20mv.
4. Remove signal, power and test equipment. Unit is ready for use.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL

The Gould D.C. Preamplifier, Model 13-4615-10 consists of an input divider, input amplifier with variable gain and zero suppression, buffer amplifier and an output amplifier with active filtering. Power for the amplifier is supplied by the recorder. See Figure 4-1 Block Diagram.

4.2 DETAILED DESCRIPTION (Schematic 286367)

a. Input Divider and Amplifier

A simplified schematic (Figure 4-2) illustrates the operation of the input section.

Amplifiers U201 and U202 are connected as non-inverting amplifiers to provide a high input resistance. Feedback resistors R206 through R212, R215 and R235 provide a differential gain of;

$$1 + \frac{R215 + R235}{R206 \text{ thru } R212}$$

A common mode signal is amplified by 1.

The resulting signals are then applied to the differential amplifier U203 along with resistors R219, R220, R221, R222, R223 and R224. The gain is adjusted to equal 1 for either input. Thus, the common mode signal is rejected and the normal mode (differential) signal is amplified by a gain of 1 and converted into a single ended output.

The input attentuator R201, R202, R203, R204 and R205 extends the useful range of the amplifier to 500 volts when placed in the X100 position.

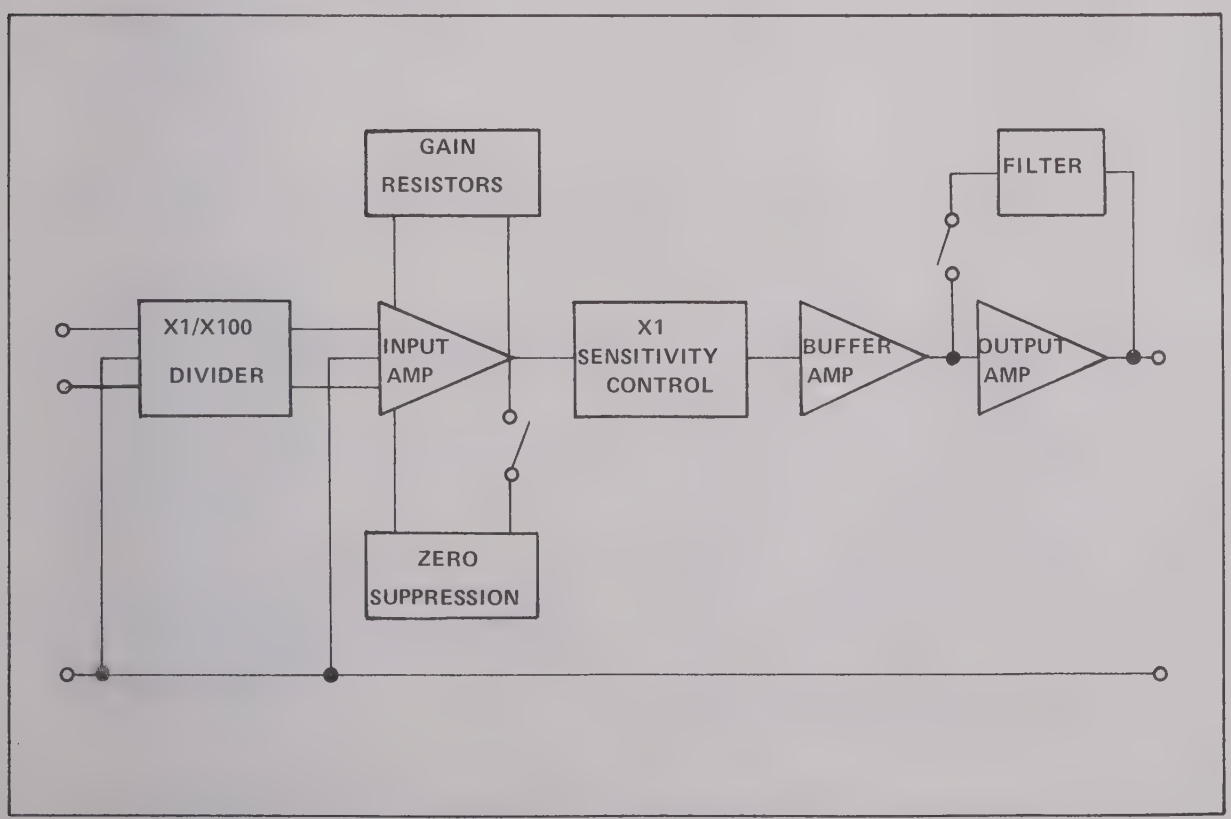


FIGURE 4-1 BLOCK DIAGRAM - D.C. PREAMPLIFIER, MODEL 13-4615-10

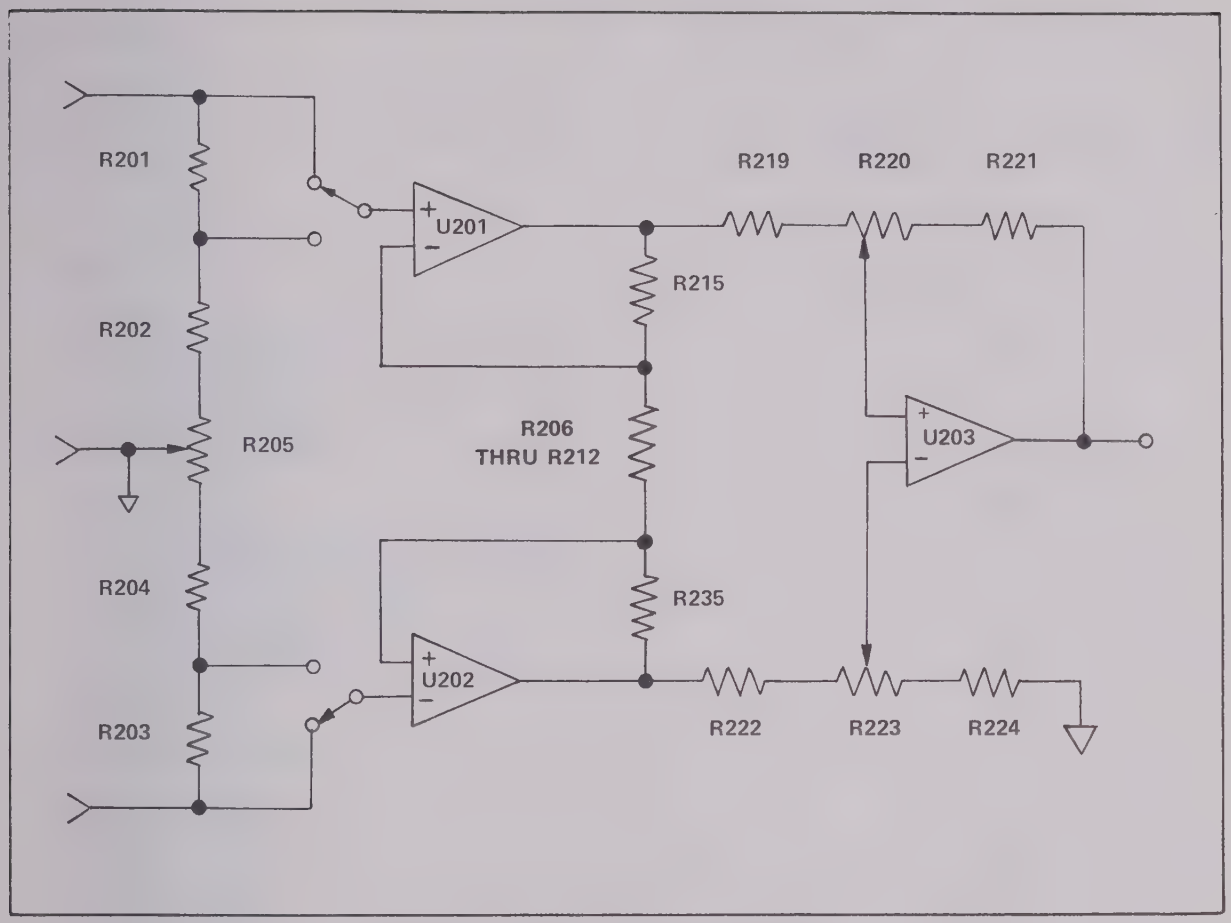


FIGURE 4-2 INPUT SECTION SCHEMATIC

b. Buffer and Active Filter

Amplifier U204 is connected as an approximately unity gain non-inverting buffer. R233 is used for output zero adjustment.

The X1 sensitivity control R101 forms a divider along with R225 and allows the gain to be varied by a factor of 2.5 to 1.

Amplifier U205 is a non-inverting unity gain amplifier when switch S102 is in the OFF position. The amplifier becomes a two pole active filter in the 1,5 and 5 position. The attenuation is approximately -12dB/Oct.

c. Zero Suppression

An isolated supply is obtained by means of transformer T201. A constant current is fed to zener CR201 to provide a stable voltage. It is divided down to either 10 volts or 1 volt and placed in the feedback loop of amplifier U202.

The suppression is done within the feedback loop, rather than at the input, in order to keep the impedance level low. Practically no extra noise is introduced by the suppression circuit regardless of the source resistance.

Switch S103 is used to select the polarity and magnitude of the suppression voltage.

SECTION V

CALIBRATION

5.1 GENERAL

In addition to detailed calibration procedures, this section contains paragraphs on troubleshooting and maintenance.

5.2 CALIBRATION

a. General

The Gould D.C. Preamplifier, Model 13-4615-10, has been accurately calibrated before shipment from the factory and should give long trouble free service. Should recalibration be required, it should be performed by qualified technical personnel only.

NOTE: This procedure is broken down into sub paragraphs by individual adjustments. Under normal conditions, complete calibration should be performed every six months. After repair of the unit or some other change in the electronics it is necessary only to recalibrate those circuits affected by the change.

b. Test Equipment Required

The following is a list of test equipment necessary for calibration.

1. Extender card and cable assembly, Gould P/N 887291.
2. AC/DC Digital Multimeter: 4½ digit, 0.05% accuracy. (DVM)
3. AC source: Wavetek Model 110 or equivalent.
4. Power Supplies: ±15vdc @ 150ma, ±5%; 13vrms, 60Hz @ 200ma.
5. DC Source: Electronic Development Corp. Model VS330H or equal.
6. Oscilloscope: Gould Model OS3300B or equivalent.
7. 2000 series recorder.

c. Preliminary Procedure

1. Remove right side cover from preamp (Figure 5-1).
2. Attach signal input cable and output connector.
3. Apply Power: ±15vdc supplies and 13 vrms or power from a series 2000 recorder. Allow 15 minutes for warmup.

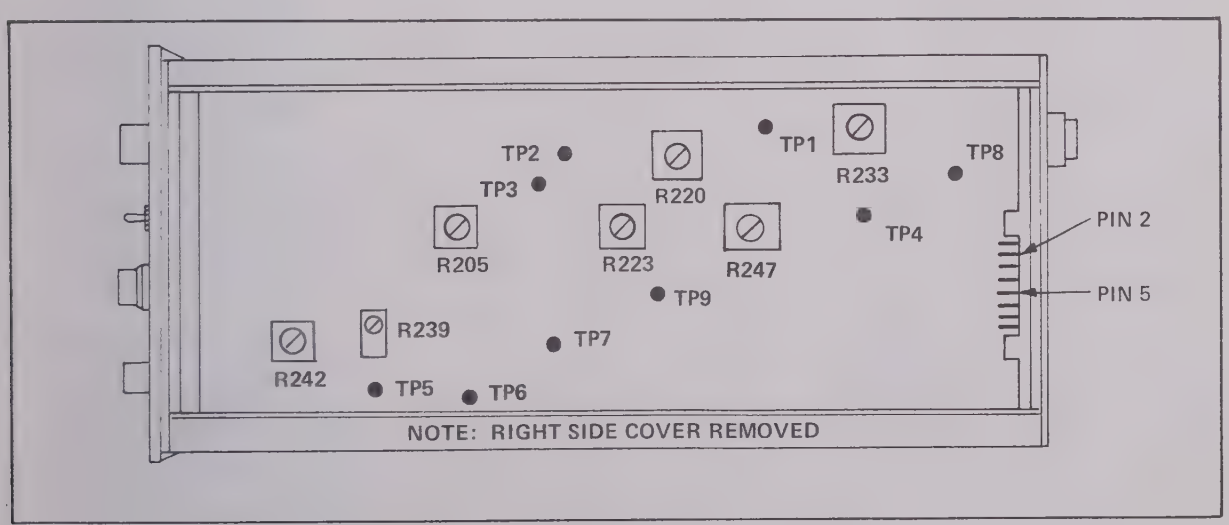


FIGURE 5-1 CALIBRATION COMPONENT LOCATION

4. Set preamp front panel controls as listed below:

CONTROL	POSITION
Volts full scale	Off
X1, X100 switch	X1
Zero Suppression, Vernier	0.0
Zero Suppression, Range (-Volts +)	Off
X1 Sensitivity	Fully C.W. (Detent Pos.)
Filter	Off
Bal	Mid-Range

5. Apply power and allow unit to warm up for 15 minutes.

5.3 CALIBRATION PROCEDURE

a. Zero Adjustment

1. Short both inputs (J-101) to common and set the VOLTS FULL SCALE switch to .025.

2. Connect the DVM to TP-2 (High) and TP-3 (Low). Adjust the front panel BAL adjustment (R-102) for 0 volts ±2mv.

3. Connect the DVM to TP-1 (High) and TP-9 (Common). Adjust R-247 for a min. output (Figure 5-1).

4. Set the VOLTS FULL SCALE switch to 5. Connect the DVM to TP-8 (High) and TP-9 (Common). Adjust R-233 for 0 volts ±2mv (Figure 5-1).

5. Set VOLTS FULL SCALE switch back to .025. and check for 0 volts ±2mv. If necessary readjust front panel BAL adjustment (R-102) for 0 volts ±2mv.

6. Rotate the VOLTS FULL SCALE switch thru all ranges with the input shorted. Make sure that there is less than ±5mv shift from 0 volts on all ranges. Repeat steps 2 thru 5 if necessary.

7. Remove jumpers from step 1.

b. Gain Adjustment

1. Set the VOLTS FULL SCALE switch to the 5V position and the multiplier switch to the X1 position.

2. Connect the plus (+) input to common and apply a -5V dc signal to the minus (-) input. Monitor the output with a DVM and adjust the output to read +5.0 volts ±5mv with the CAL 1 pot, R220 (Figure 5-1).

3. Disconnect the source and connect both inputs to common and note the zero reading with the VOLTS FULL SCALE switch set to 5V. Remove jumpers to common.

4. Apply a +5V dc signal low to common and high to plus input. Short plus and minus inputs together (common mode). Adjust the output to read the same as in step 3, with the CAL 2 pot, R223 (Figure 5-1).

5. Set the multiplier switch to X100 and the VOLTS FULL SCALE switch to 5V. Note the zero reading.

6. Apply a 100vdc signal as in step 4 and use the input BAL pot, R205 (Figure 5-1), to adjust the output to read the same as with zero applied voltage. Remove the input voltage and check zero. Repeat the various steps if necessary. Remove jumpers.

7. Apply full scale normal mode voltages to all ranges. The output should read 5V ±25 mv on all ranges.

c. Zero Suppression Adjustment

1. Short both inputs (J-101) to common (ring).

2. Connect DVM to TP-8 (High) and TP-9 (Common). (Figure 5-1).

3. Rotate the front panel VERNIER dial to 10.0 and lock it in position.

4. Set VOLTS FULL SCALE switch to 5 and the "-VOLTS+" switch to +10.

5. Adjust R-239 (Figure 5-1) for an output voltage of -10 volts ±2mv.

6. Reset the "-VOLTS+" switch to +1. Adjust R-242 for an output of -1.0 volt ±.2mv. (Figure 5-1).

7. Reset the "-VOLTS+" switch to -1. The output should be +1.0 volt ±.2mv. (R-242), Figure 5-1).

8. Reset the "-VOLTS+" switch to -10. The output should read +10 volts ±2mv. (R-239, (Figure 5-1).

9. Remove jumpers from step 1.

5.4 TROUBLESHOOTING

a. General

Troubleshooting may be performed in conjunction with the schematic (in the parts section) and the necessary bench equipment listed in paragraph 5.2. When the preamplifier is used with the Gould Series 2000 recorders refer to the troubleshooting table in Section V of the recorder manual.

5.5 MAINTENANCE

a. General

Maintenance on the preamplifier is limited to cleaning only.

b. General Cleaning

CAUTION:

1) **Before attempting to clean the preamp, turn power off and remove from enclosure.**

2) **Avoid use of chemical cleaning agents which might damage plastic or printed surfaces. Do not use chemicals which contain toluene, cellusolve, acetone or similar solvents.**

EXTERIOR: Remove loose dust with a soft cloth or small paint brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. **DO NOT USE ABRASIVE CLEANERS.**

INTERIOR: Dust in the interior should be removed occasionally due to its electrical conductivity under high humidity conditions. Blow off accumulated dust with dry low pressure air. Remove any dirt which remains with a soft paint brush or a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or printed circuit boards.

SECTION VI

SIGNAL SOURCES

6.1 GENERAL

An understanding of signal sources, amplifier input configurations and signal connections in electrical measurement is vital to prevent noise or ambient conditions from overshadowing desired physical or electrical variables. Final data may be useless unless a signal source is properly selected or identified and used with an appropriate signal conditioning amplifier.

NOTE: More information can be obtained by ordering "Elimination of Noise in Low-level Circuits", No. 1269A from Gould Inc., Cleveland.

Signal Sources

Transducer or signal source selection is the first step in most measurement or recording applications. Low impedance devices are preferred, to reduce system noise and to minimize the shunting effect (loading) which the measuring instrument imposes on the source.

The signal source must be properly identified so that it can be matched with an appropriate amplifier. Signal sources fall into six classes, according to the configuration of the output circuit. These are summarized as follows:

A SINGLE ENDED-GROUNDED signal source has two output terminals, one of which is connected to source ground as shown in Figure 1-A. The a-c line powered signal generator with a two terminal grounded output is typical.

A SINGLE ENDED-FLOATING signal source has two output terminals which are isolated from ground as shown in Figure 1-B. A FLOATING output can be grounded or reversed without disturbing the circuit. The dry cell battery, the output from a magnetic head, or a two terminal battery powered signal generator are typical examples.

A SINGLE ENDED-DRIVEN OFF GROUND signal source has two output terminals which are driven off ground by a second voltage, as shown in Figure 1-C. A DRIVEN OFF GROUND signal source can NEVER be grounded. A resistive shunt installed in the hot side of a power line or d-c bus for measuring current is a classic example.

A BALANCED-GROUNDED signal source has two active output terminals which have equal impedance to a common ground, as shown in Figure 1-D. The output terminals can be reversed without disturbing the circuit. A four arm wheatstone bridge output that is excited from a grounded power supply is a good example.

A BALANCED-FLOATING signal source is one that has two active output terminals which have equal impedance to common point that is floating, is shown in Figure 1-E. A four arm wheatstone bridge output that is excited from a FLOATING power supply or a center-tapped transformer secondary are typicial examples. The output terminals can be reversed or the common terminal can be grounded without disturbing the circuit.

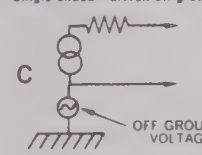
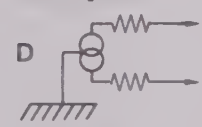
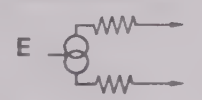
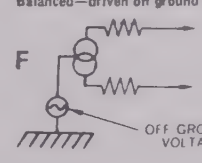
Source	Description	Examples
Single ended—grounded 	Two output terminals one of which is connected to ground.	AC line powered signal generator
Single ended—floating 	Unbalanced output, isolated from ground. Can be grounded without disturbing circuit.	Dry cell battery. Magnetic tape head. Battery-powered signal generator.
Single ended—driven off ground  	Unbalanced output, driven off ground by second voltage source. Cannot be grounded.	Resistive shunt in hot side of line or bus—for measuring current.
Balanced—grounded  	Terminals have equal impedance to common ground.	Four arm Wheatstone bridge, excited from grounded DC supply.
Balanced—floating  	Terminals have equal impedance to floating common point. Common point can be grounded without disturbing circuit.	Four arm Wheatstone bridge excited from floating DC supply. Center-tapped transformer.
Balanced—driven off ground  	Terminals have equal impedance to common point, driven off ground by a second voltage source. Cannot be grounded.	Differential output recorder amplifier (e.g., device with ±30 v output, operates in 0—60 v range).

FIGURE 6-1
CLASSIFICATION OF SIGNAL SOURCES

A BALANCED-DRIVEN OFF GROUND signal source has two active output terminals which have equal impedance to a common point which is driven off ground by a second voltage, is shown in Figure 1-F. The active output terminals can be reversed to invert signal polarity, but it can NEVER be grounded without disturbing or destroying the signal source. An example is a differential output amplifier which produces an output of ±30 volts, but operates at about +60 volts d-c off ground.

Identification of Signal Sources

If an electrical schematic is not available, a signal source may be identified by using one channel of a Gould recorder plus an ohmmeter. To identify a two-terminal source, the ground or low recorder input terminal is connected to a good solid ground at the signal source. With the source turned ON, the high side of the recorder input is connected to one output terminal of the signal source and then the other. The amplitude and character of these two measurements provide the required information about the source.

A zero signal from one signal source terminal and a usable signal from the other indicate a **single ended-grounded** source. Equal 60Hz noise signals from both terminals indicate a floating source, and if there are only two terminals a floating source is probably **single ended-floating**. A resistance of several hundred megohms from each terminal to ground confirms that the source is floating. Usable but unequal signals from the two terminals indicate a driven off ground output. The average of the two signals is the off ground or common mode voltage, the difference is the signal amplitude. If the two-terminal source is turned OFF and the ohmmeter shows unequal resistance from the terminals to ground, the source is probably **single ended-driven off ground**. For all three source types, an ohmmeter across the two terminals with the source turned OFF indicates the source resistance.

To identify a three terminal signal source, the **ground** or **low** recorder input terminal is again grounded at the signal source. The **high** recorder terminal is connected to each of the three source output terminals in sequence.

A zero signal from one terminal and equal or similar signals from the other two indicates a **balanced-grounded** source. With the signal source turned OFF, resistance readings from ground to each terminal identify the ground terminal and the source resistance of each active output terminal to ground. Equal 60Hz noise signals from the three terminals, and a resistance of several hundred megohms between all three terminals to ground, indicates a **balanced-floating** source. With the source turned OFF, ohmmeter readings across the three output terminals reveal the common terminal, the source resistance of each leg to common, and the total source resistance.

A usable signal from one terminal to ground and nearly equal signals from the other two, indicates a **driven off ground** source. The terminal with the minimum signal or a signal different from the other two is probably the common terminal, and the signal from it to ground is the off-ground or common mode voltage. With the source turned OFF, equal resistance readings to ground from any pair of terminals and a smaller resistance to ground from a third terminal confirms that the source is **balanced-driven off ground.** Resistance readings taken across the three output terminals reveal the common terminal, the output resistance of each leg to common and the total source resistance.

Balanced to Common Amplifier

When a Balanced to Common Amplifier is used with any of the 6 types of signal sources, the two active amplifier input terminals are connected to both sides of the signal source. The connections can be reversed if a change in polarity of the output is desired. The signal cable shield is connected to the source and the common of the amplifier as shown in Figures 6-2 through 6-7.

When operating with driven off ground sources as shown in Figures 6-6 and 6-7 it is important to remember that the output of the amplifier must not be grounded. In addition the signal cable must have enough insulation resistance to withstand the common mode voltage from the shield to the input leads and to the outside.

Ground Loop

The previous discussion concerned the correct ways in which to operate an amplifier with different sources; in particular grounding was emphasized. Incorrect grounding procedures can produce ground loops which in turn can produce 60Hz noise currents or other unwanted signals. The mag-

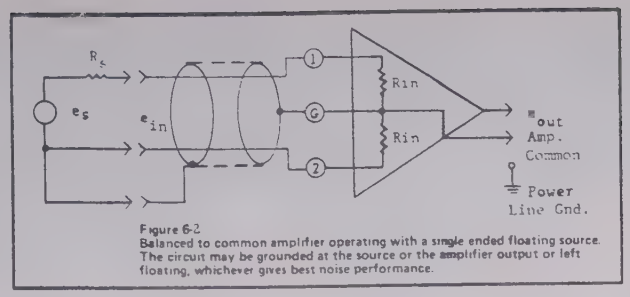


Figure 6-2
Balanced to common amplifier operating with a single ended floating source. The circuit may be grounded at the source or the amplifier output or left floating, whichever gives best noise performance.

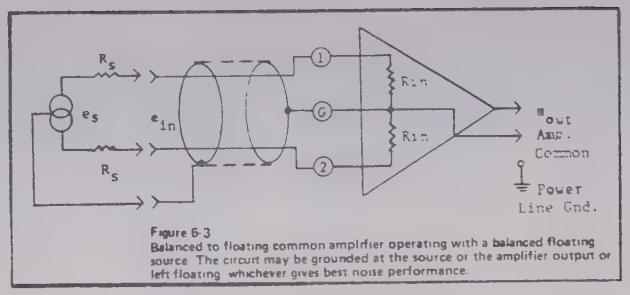


Figure 6-3
Balanced to floating common amplifier operating with a balanced floating source. The circuit may be grounded at the source or the amplifier output or left floating whichever gives best noise performance.

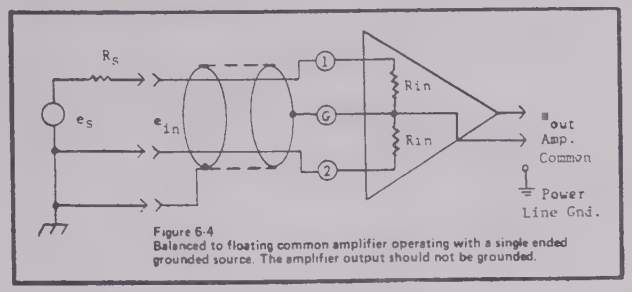


Figure 6-4
Balanced to floating common amplifier operating with a single ended grounded source. The amplifier output should not be grounded.

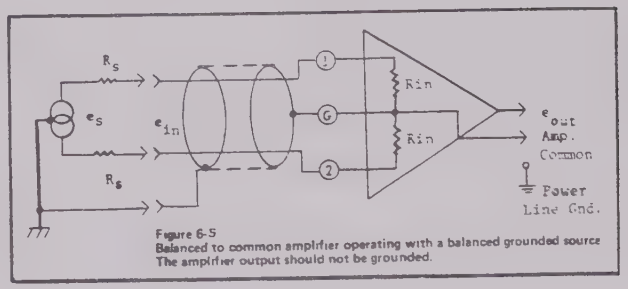


Figure 6-5
Balanced to common amplifier operating with a balanced grounded source The amplifier output should not be grounded.

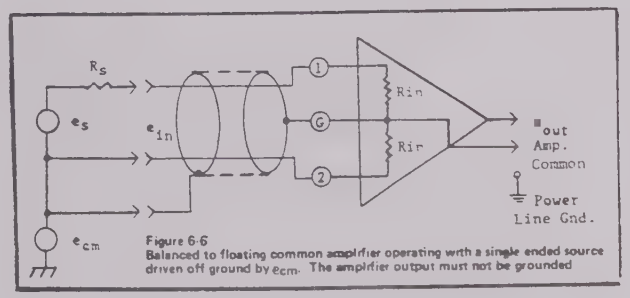


Figure 6-6
Balanced to floating common amplifier operating with a single ended source driven off ground by e_{cm}. The amplifier output must not be grounded

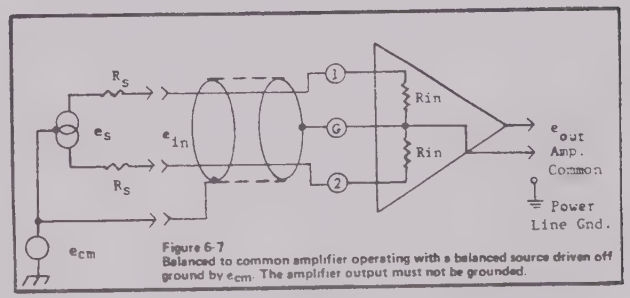


Figure 6-7
Balanced to common amplifier operating with a balanced source driven off ground by e_{cm}. The amplifier output must not be grounded.

nitude of ground loop current is directly proportional to the difference in potential between two grounds. In some cases a ground loop can produce so much 60Hz noise that it will obscure millivolt signals.

To illustrate how a ground loop produces circulating currents leading to excess noise, refer to Figure 6-8. The potential difference between grounds produces three paths for ground loop currents to flow:

1. Loop current through the cable shield and circuit common.

2. Loop current through the low input lead, through Rin to circuit common.

3. Loop current through e_s, R_s, the high input lead, through Rin_1 to circuit common.

NOTE: If there were no resistance, R_C, in the cable shield loop currents 2 and 3 would be zero. In addition, if $R_S = 0$, current 2 and 3 would be equal and cancel each other. However, this is never the case. Both R_S and R_C may be very small, but they can still cause problems.

In addition to the three loop currents shown, the potential difference, e_{cm}, can be coupled to the two input leads through distributed cable capacitance to produce other loop currents. As can be seen, loop current can find many paths to circulate through the measurement system. However, no matter how simple or complex the paths, it can only cause problems.

The amplifier in Figure 6-9 is connected the correct way - only grounded at one point. Note that there is no path through the shield or amplifier inputs for loop current to flow. A marked improvement in noise performance will be noted between the two systems.

A single ended, grounded source was used as an example since this type of source will usually exhibit greater noise with incorrect grounding as opposed to a balanced, grounded source. No matter what the source best performance will always be obtained by following good grounding techniques.

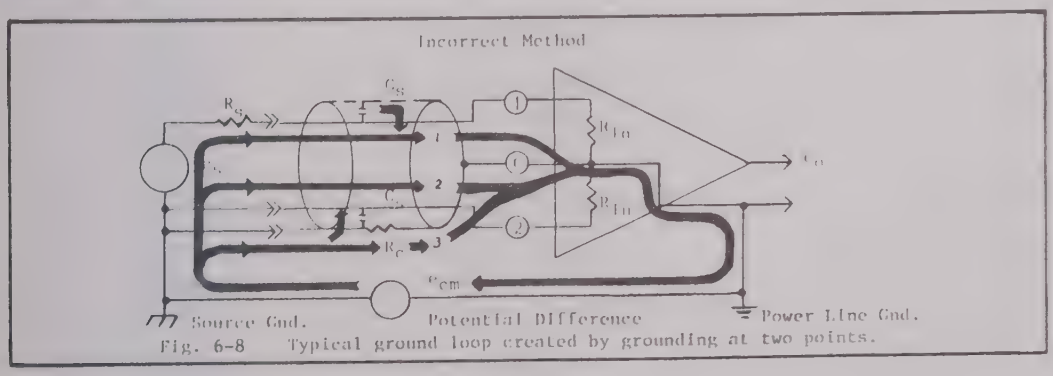


Fig. 6-8 Typical ground loop created by grounding at two points.

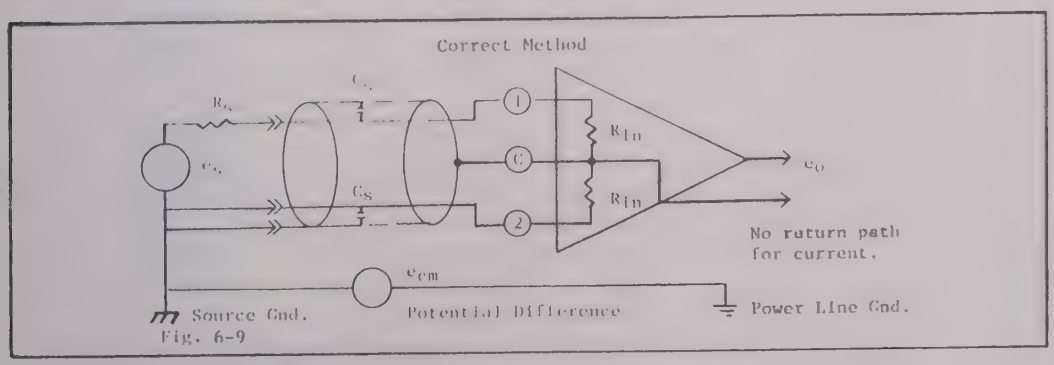


Fig. 6-9

SECTION VII

PARTS IDENTIFICATION

7.1 GENERAL

This instrument has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the instrument.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the instrument.

NOTE: Check to be sure the schematic number and revision letter stamped on the rear of the instrument agree with the number and revision letter on the schematic contained in this section.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name, model number, and serial number of the instrument.

   For Example: DC Preamplifier Model 13-4615-10 Serial Number _____

2. Description of the part as listed in the manual.

3. Gould part number.

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

GOULD MEDIUM GAIN D.C. PREAMPLIFIER
MODEL 13-4615-10
FIGURE 7-1

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	786073	Front Panel Assembly	
2	285652-2	Knob	
3	686765	Switch, Toggle	S101
4	663800-1	Nut, Knurled	
5	285652-1	Knob	
6	685120	Rotary Switch Assembly	S103
7	285651-3	Knob	
8	246393-103	Resistor, Variable	R101
9	not used		
10	685113	Resistor Assembly, Variable	R102
11	663800-6	Nut, Knurled	
12	285650	Knob	
13	284990	Knob, Turns Counting	
14	685121	Resistor Assembly, Variable	R103
15	286151-1	Switch, Rotary	S102
16	9-281501-9	Connector	P201,P202
17	281502-1	Contact (Not shown, Part of item 16)	
18	685944-1	Frame, Top or Bottom	
19	886331	Amplifier Board Assembly (See Fig. 7-2)	
20	686335	Input Connector Assembly	J101

GOULD MDEIUM GAIN D.C. PREAMPLIFIER
MODEL 13-4615-10 (continued)
FIGURE 7-1

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
21	686421	Cover Assembly, Left Side	
22	285943	Cover, Right Side	
23	785946	Panel Assembly, Rear	
24	386317	Sub Panel, Front	

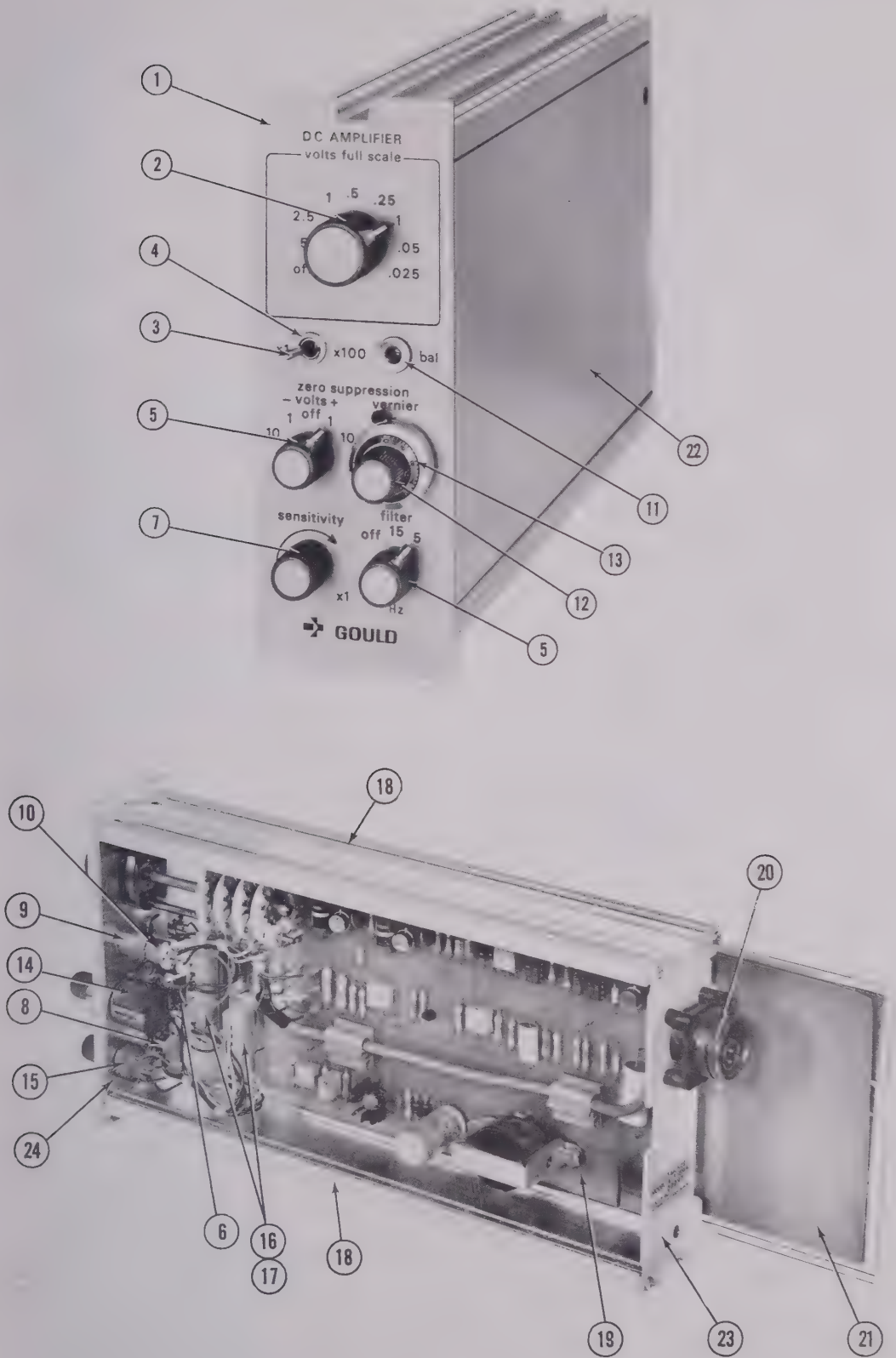


FIGURE 7-1 MEDIUM GAIN D.C. PREAMPLIFIER

GOULD MEDIUM GAIN D.C. PREAMPLIFIER, MODEL 13-4615-10
ELECTRICAL PARTS LIST
AMPLIFIER BOARD ASSEMBLY (886331)
FIGURE 7-2

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C201, C202	281344-103	Capacitor
C203	240352-102	Capacitor
C204, C205	262585-106	Capacitor
C206	5-241145-224	Capacitor
C207	5-241145-684	Capacitor
C208	240352-103	Capacitor
C209, C210	231707-336	Capacitor
C211	240352-102	Capacitor
C212	281509-477	Capacitor
C213	240352-102	Capacitor
CR201	247151-2	Semiconductor, 1N942
CR202	249747	Semiconductor, 1N752A
CR203, CR204	231887	Semiconductor
CR205, CR206	293563-3	Diode
J201, J202	281711-4 & 5	Connector
Q202	266484	Transistor, 2N4036
S	262176	Heat Sink
R201	R1-286685-10003	Resistor
R202	R1-284694-10001	Resistor
R203	R1-286685-10003	Resistor
R204	R1-284694-10001	Resistor
R205	284878-201	Resistor, Variable
R206	R1-281345-15001	Resistor
R207	R1-281345-27780	Resistor
R208	R1-281345-11690	Resistor
R209	R1-281345-644R50	Resistor
R210	R1-281345-206R10	Resistor
R211	R1-281345-101R50	Resistor
R212	R1-281345-100R30	Resistor
R213	5-115559-224	Resistor
R214	1-265969-10002	Resistor
R215	R1-281345-10001	Resistor
R216	5-241111-101	Resistor
R217	5-115559-224	Resistor
R218	5-241111-101	Resistor
R219	25-265969-10001	Resistor
R220	284878-201	Resistor, Variable
R221-R222	25-265969-10001	Resistor
R223	284878-201	Resistor, Variable
R224	25-265969-10001	Resistor
R225, R226	1-265969-50000	Resistor

GOULD MEDIUM GAIN D.C. PREAMPLIFIER, MODEL 13-4615-10
ELECTRICAL PARTS LIST
AMPLIFIER BOARD ASSEMBLY (886331) — Continued
FIGURE 7-2

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R227	1-265969-85000	Resistor
R228	1-265969-16901	Resistor
R229	1-265969-39201	Resistor
R230	25-265969-12502	Resistor
R231	25-265969-10001	Resistor
R232	50-128182-4954	Resistor
R233	284878-103	Resistor, Variable
R234	1-265969-10002	Resistor
R235	R1-281345-10001	Resistor
R236, R237	Not Used	
R238	25-265969-900R0	Resistor
R239	269085-201	Resistor, Variable
R240	1-265969-50R00	Resistor
R241	1-265969-250R0	Resistor
R242	284878-100	Resistor, Variable
R243	25-265969-98R00	Resistor
R244	5-241111-472	Resistor
R245, R246	5-115557-105	Resistor
R247	284878-103	Resistor, Variable
R248, R249	5-241111-103	Resistor
S201	286085	Switch, Rotary
T201	286132	Transformer
U201, U202	294181-3	Integrated Circuit, AD547LH
U203, U204	280863-3	Integrated Circuit, 741
U205	289385	Integrated Circuit, 13741
--------	270903-11	Clamp
--------	267235	Jumper

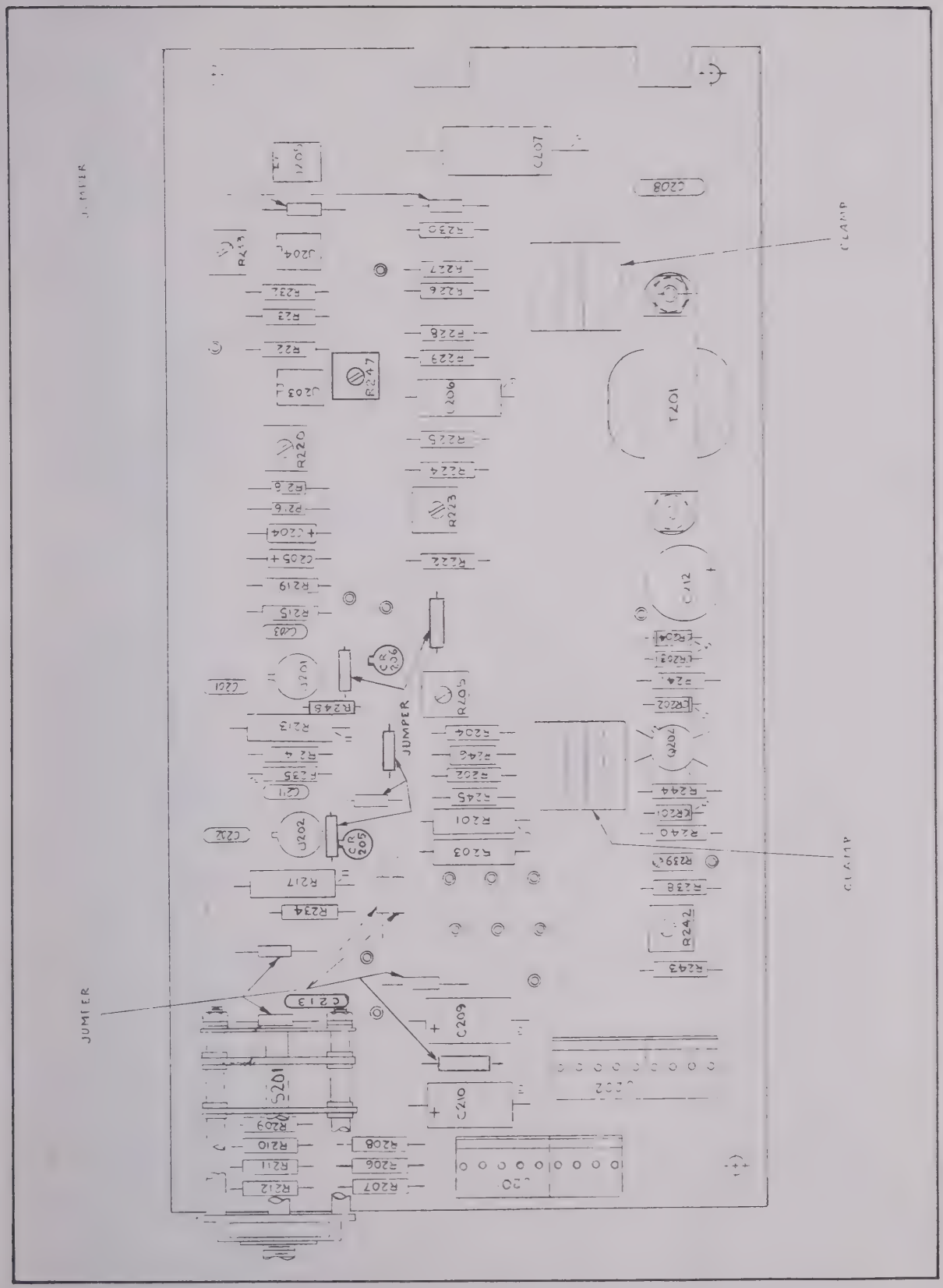
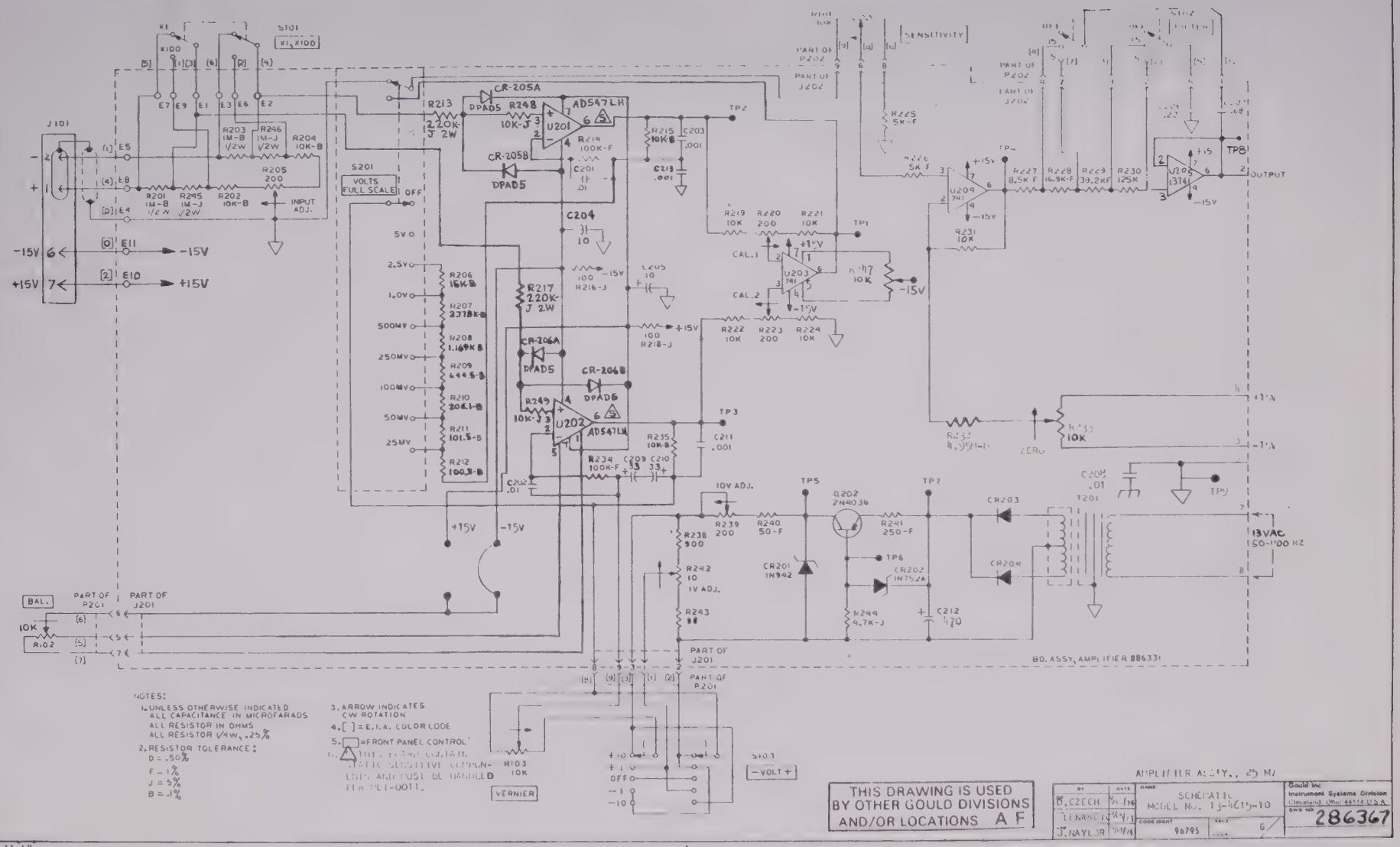


FIGURE 7-2 AMPLIFIER BOARD ASSEMBLY 886331

REV. N-2



NOTES:

1. UNLESS OTHERWISE INDICATED
   ALL CAPACITANCE IN MICROFARADS
   ALL RESISTOR IN OHMS
   ALL RESISTOR 1/4W, ±2%
2. RESISTOR TOLERANCE:
   D = .5%
   F = 1%
   J = 5%
   B = .1%
3. ARROW INDICATES CW ROTATION
4. [ ] = E.I.A. COLOR CODE
5. □ = FRONT PANEL CONTROL
6. △ = THIS PCB CONTAIN STATIC SENSITIVE COMPONENTS AND MUST BE HANDLED PER PCI-0011.

THIS DRAWING IS USED BY OTHER GOULD DIVISIONS AND/OR LOCATIONS A F

AMPLIFIER ASSY., 25 MV

BY	DATE	NAME	SCHEMATIC MODEL NO. 13-4015-10	Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.
B. CZECH	7/76			
ENGINEERING	7/76		CODE IDENT 96795	SIZE G
J. NAYLOR	7/76			DWG NO 286367

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